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Stockage Determination Made Easy

by Dr. Kenneth Girardini, Chief Warrant Officer (W–5) Arthur W. Lackey, USA (Ret.), and Eric Peltz

Every brigade combat team (BCT) and support brigade in the Army has a mobile minidistribution center that stocks repair parts and perhaps also class II (clothing and individual equipment), IIIP (packaged petroleum, oils, and lubricants), and IV (construction and barrier materials) items with national stock numbers (NSNs) in its authorized stockage list (ASL). This minidistribution center, called the supply support activity (SSA), is *the* key to high equipment readiness. When equipment fails and becomes not mission capable (NMC), but the needed parts are on hand in the SSA, that equipment can be returned to action very quickly. However, when the parts are not available in the supporting SSA, it can sometimes take awhile to get them, which only delays returning equipment to a mission capable status.

In operations in Iraq, getting the part from the United States by air (if the part is well positioned for quick shipment) or from theater stocks in Kuwait takes an average of a little more than 10 days, with some shipments taking longer. If the item is in short supply at U.S. distribution centers, the wait can be much longer. Not having parts in the ASL sometimes leads units to take extraordinary actions, such as controlled exchanges, to get equipment back on line rather than accept lengthy downtimes on critical end items.

Studies by RAND Arroyo Center have confirmed that high-performing ASLs have the greatest direct affect on equipment readiness through their impact on supply chain processes and resources. (Reliability, of course, is the other central factor affecting equipment readiness.) For example, a RAND Arroyo study at the National Training Center at Fort Irwin, California found that a 10-point swing in the ASL fill rate changed the equipment readiness rate by 4 percentage points. However, Army ASL fill rates were often under 20 percent in the late 1990s because of very limited breadths of parts and some issues concerning how depths were computed. ("Breadth" refers to the number of different parts stocked. "Depth" refers to the number of each part stocked.)

Development of Dollar Cost Banding

To address the low ASL fill rates, RAND Arroyo developed Dollar Cost Banding (DCB). Piloted in 1998, DCB introduced three things to ASL management: tying the decision of what and how much to stock to both the benefits produced and the resources required, emphasizing the need to deal with highly variable demand, and using automated exclusion criteria.

The hypothesis underlying DCB development was that, even if the benefit of adding a part is relatively low, if the part's cost and size are minimal and its absence can affect readiness, it may be worth stocking. The DCB concept was introduced using heuristics that adjusted add-and-retain thresholds in terms of the number of demands based on item cost (inventory investment) and size (storage space). Basically, the DCB rules said that the smaller and less expensive an item is, and if it

is coded essential or has had high-priority demands, the threshold for stocking it should be lessened. The add-and-retain criteria for big, expensive items that are often critical to readiness were not changed. This change increased the breadth of ASLs by adding more of the small, inexpensive items that are often needed in conjunction with the more expensive items to correct NMC or deadlining faults.

The second, and less well known, aspect of DCB was a complete change in how inventory depth is computed. Inventory levels with DCB are set by using iterative simulations of the demand streams at the national item identification number (NIIN) level to achieve customer-wait-time goals that vary based on the investment and storage resources associated with the NIIN. This contrasts greatly with the former "days of supply" method, which used only the mean demand rate and thus did not compensate for the variability or timing of demands. (Demands during peak training periods were averaged or were smoothed out with zero or low demands during periods in garrison.)

The third aspect of DCB was a set of parameters that automatically exclude certain NIINs that are not desirable to stock in SSAs in order to reduce the ASL review workload. Examples of the criteria used are acquisition advice code, nomenclature, class of supply, and Federal supply class. The parameters have been continually updated based on feedback from the field. The central idea behind exclusions was to keep items from being recommended for ASL stockage that were not critical to warfighting or that the unit could otherwise wait to obtain through an order-ship cycle.

Initially, DCB was implemented by having a central team at RAND develop the ASL recommendations. The central team also assisted in reconfiguring warehouse storage and participated in the SSAs' review of the recommendations. After successful pilots, this led to the incorporation of DCB into Army policy in 2000 and a rapid, successful rollout through about half the SSAs in the Army. Fill rates increased by about 10 percent in those SSAs that adopted DCB. In 2001, DCB became available in the Integrated Logistics Analysis Program (ILAP), which allowed SSAs to initiate and run their own ASL reviews. However, without the role played by the central team, the results became less consistent as inventory expertise varied among SSAs and other demands on personnel time sometimes impeded effective implementation of the recommendations.

Introduction of Enhanced DCB

At about this time, RAND Arroyo Center developed the Equipment Downtime Analyzer (EDA), which also was added as a module within ILAP. The EDA archives daily NMC equipment reports. This information is very valuable because it identifies all of the parts ordered to return a system to mission capable status. With EDA data, it is now possible to develop a critical parts list of those parts that consistently deadline Army equipment.

The EDA critical parts list was used to develop Enhanced DCB (EDCB), which, initially, simply changed the criticality criteria. In DCB, a part was considered "critical" based on the essentiality code or the use of high-priority requisitions for the part. The problem was that, with these rules, most parts (85 percent) are deemed "critical." Using the EDA critical parts list, we have found that the list of true readiness drivers is much narrower—now only 35 percent of demanded items. Therefore, EDCB allows us to concentrate the allocation of limited SSA storage

capacity and inventory investment on these more critical parts.

EDCB was piloted with two BCTs at Fort Riley, Kansas, in 2002. This pilot targeted three key systems—the M1A1 Abrams tank, the M88A1 recovery vehicle, and the M9 armored combat earthmover—with great success. The readiness-driver fill rates for targeted systems improved considerably. Consequently, awaiting parts time, and, thus, overall time for deadlining repairs, fell dramatically, thereby increasing readiness for each BCT.

Impact of Operation Iraqi Freedom

Before implementation of EDCB could be expanded, Operation Iraqi Freedom (OIF) began. This put further rollout of EDCB on hold as units that were to prototype the new algorithm turned their attention to deployment preparations and then combat operations. When units initially deployed to OIF, they generally took the ASLs they had at home with little change (or they fell in on ASLs from Army pre-positioned stocks). Units that had been involved in the DCB rollout found that their home-station ASLs were relatively effective, at least initially. For most units, the breadth of parts demanded in OIF was similar to what they experienced when training at home station, so accommodation rates held up.

However, a lack of connectivity with Standard Army Management Information Systems (STAMIS), combined with severe distribution challenges in 2003, significantly hampered replenishment and quickly depleted those deployed ASLs. Without reliable replenishment, ASL satisfaction rates fell to less than 10 percent, making the ASLs ineffective. Another factor hampering the recovery of satisfaction rates was that depth in the home-station ASLs that units deployed with had been calculated using the actual replenishment times for each NIIN at home station (a minimum of 10 days was enforced); but those replenishment times had not yet been achieved in OIF.

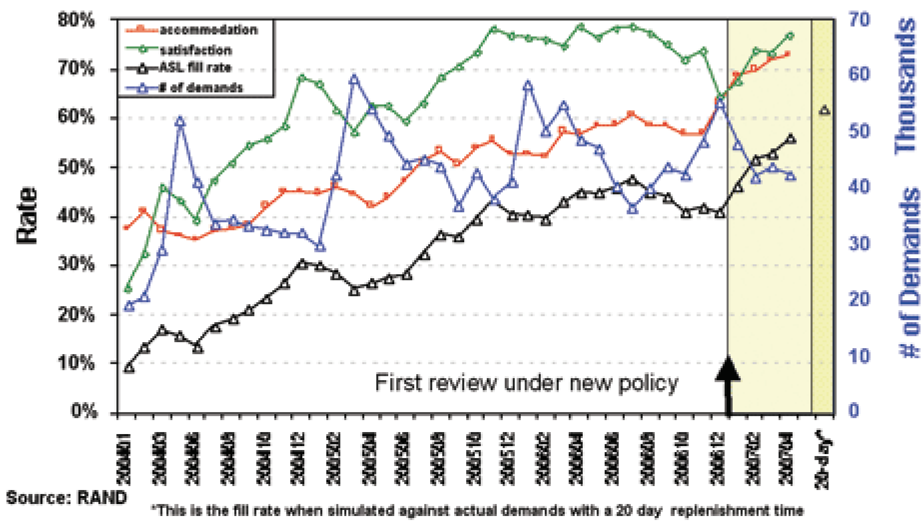
Realizing the need to better match ASLs with growing demands, theater logisticians began ASL reviews using DCB (in ILAP), which did lead to improvements in depth by using actual replenishment lead times and demand rates for OIF. Combined with improved distribution, these enabled ASLs to recover to about 30-percent fill rates. However, additional problems hampered the effectiveness of ASL reviews: Deployed demand histories were limited in duration to less than the 2 years used in DCB; as rotations began, many units were task organized, and so deployed SSAs were used to support different types of units; and equipment changes sometimes occurred (such as the addition of up-armored high-mobility, multipurpose, wheeled vehicles). All of these factors rendered the use of deployed SSA demand histories only partially effective for forecasting future demands and setting inventory levels.

To tackle these issues, RAND began to assist in building virtual demand histories for units. These histories were based on moving unit demand streams at the company level, making adjustments to account for limited demand histories, and using the demand histories of proxy units to model requirements for equipment new to a unit. Using these demand streams, EDCB was applied, with recommendations passed to SSAs in Iraq, Kuwait, and Afghanistan.

Between late 2004 and the middle of 2006, acceptance and implementation of the recommendations was mixed. Those SSAs that implemented EDCB experienced dramatic ASL improvements; those that did not saw stagnant performance. This led

to 20- to 30-point gaps in fill rates among SSAs supporting similar units. ASL reviews also often took a long time, which impeded performance improvement during a significant portion of year-long rotations. However, where the recommendations were implemented, readiness-driver fill rates climbed significantly above those of non-readiness drivers. Despite variations by SSAs in the adoption of EDCB recommendations, the overall readiness-driver fill rate for OIF had climbed to almost 50 percent by late 2006.

One issue that sometimes created delays was the sheer time needed to review the thousands of recommendations that came from DCB and EDCB. This problem was aggravated if the recommendations did not fit within the existing storage configuration of an SSA. Another challenge was that the large numbers of ASL changes required to implement the recommended "adds," "deletes," and requisition objective (RO) changes created a greater workload than some SSAs could handle given their daily ongoing work.



Authorized stockage list (ASL) performance metrics for readiness drivers.

Enhancement of ASL Management With IROC

Based on these OIF issues, and other lessons learned from this body of ASL research, RAND Arroyo Center has developed a new model for computing ASL recommendations called the Inventory Readiness Optimizer with Constraints (IROC).

IROC is essentially a product improvement of the EDCB algorithm. It is based on a mixed-integer programming formulation that is intended to optimize the readiness contribution of the ASL, subject to constraints on inventory investment, transition workload, and the number and volume of storage locations by type (such as small bin, medium bin, shelf, rack, and bulk). A weighting derived from the EDA database indicates the relative criticality of parts, rather than simply considering parts as critical or not. The recommendations from this process were then input into a simulation to determine the resulting readiness (down days) and to establish curves of ASL performance and readiness impacts versus resources.

IROC was prototyped among units undergoing modularity transformation and led to many insights on how to overcome the OIF ASL issues (particularly storage feasibility and transition workload issues) affecting the implementation of ASL recommendations.

RAND Arroyo Center uses IROC results to fine-tune EDCB and improve the recommendations provided to deployed units by—

- Incorporating tighter storage constraints that are generally feasible for storage locations.
- Reducing the recommended changes in ways that produce the most potential benefit while limiting the transition workload. This is done by limiting "adds" to faster moving readiness-drivers; "increases" to fast movers that exhibit poor satisfaction rates; "deletes" to items with no demand or that are no longer applicable; "decreases" to items that can be decreased if there is a change in bin size and performance remains high; and "no change" to calculated recommendations that would not significantly affect inventory investment and storage and would produce only a marginal change in performance. (Most of the recommendations for high-performing ASLs are now "no change.")

Institution of a New ASL Policy

Observing the variation of ASL performance among SSAs of similar type, and recognizing that EDCB produced effective solutions that could be readily implemented, the Army's Deputy Chief of Staff, G–4, released a pilot ASL policy for Southwest Asia in November 2006 after coordination with the Army Materiel Command, the Army Combined Arms Support Command, and the Coalition Forces Land Component Command of U.S. Central Command. Previously, Army supply policy had dealt with the percentage of lines not recommended for the ASL that commanders could add in the ASL review process. However, Army policy did not mandate the percentage of recommendations for demand-supported lines that had to be accepted.

To address this gap, the fundamental change introduced by the new ASL policy is to provide only a summary (such as number of changes and new storage requirements by storage category) of the majority of recommendations that involve only small changes to the overall cost and volume, or cube, of the ASL. If the summary is acceptable, the bulk of the recommendations can be implemented without the need for a line-by-line review. SSAs only review lines that satisfy one of the following criteria—

- Increases (which could be the result of adding a new ASL line) or decreases (which could be the result of deleting an existing ASL line) in cube greater than 8 cubic feet.
- Increases or decreases of RO value of more than $10,000.
- All items—even if no change is recommended—that have an RO value of more than $100,000 or a cube greater than 100 cubic feet.
- Items that have an RO greater than 500 and all operation and maintenance Army-funded NIINs.

Thus, beyond targeting improved performance, this new pilot ASL greatly reduces the work associated with making ASL review decisions while still allowing units to do detailed reviews of the lines that account for 85 to 90 percent of the ASL cube and dollar value. This new ASL policy also sets forth a 2-week review time limit on this subset of items. Finally, it calls for ASL updates every 3 to 4 months rather than on an annual basis. The intent of the updates is to implement a small number of adjustments to the ASL that could make a significant performance difference. In a dynamic environment such as OIF and Operation Enduring Freedom, this is particularly important.

This policy was first implemented for SSAs in Iraq in December 2006. All 24 SSAs were changed in a 40-day time period, with an average of 17 days per SSA—a much improved performance over the weeks and even months that the process was taking previously. The numbers of lines that had to be reviewed by SSAs were approximately—

- 150 to 200 for an infantry BCT.
- 300 for a heavy BCT.
- 400 for a combat aviation brigade.

The first quarterly ASL update of these SSAs was made over justa few days in late March 2007 and typically involved 30 to 60 recommendations for each SSA that had to be reviewed under the new Army policy.

Best of all, performance has risen to an all-time high. As shown in the chart at left, the readiness-driver accommodation rate for SSAs in Iraq has jumped from the high 50-percent range to about 73 percent. This is about the limit achievable without adding very low demand items that are very difficult to accurately forecast and often do not recur from year to year at the SSA level. Satisfaction is at about 77 percent, but that should climb as stocks continue to arrive to fill the new inventory levels.

Some recent distribution problems have caused replenishment times to exceed the 20-day replenishment wait time (RWT) planning factor; these problems are in the process of being corrected. Still, the readiness-driver fill rate has reached 56 percent. Replaying demands with the 20-day RWT indicates that the fill rate would have increased to 63 percent, getting close to the feasible limit given current storage constraints and the large number of very low demand parts.

The G–4 staff is also in the process of implementing a companion change. In this article, we have been referring to the readiness-driver fill rate and associated diagnostic accommodation and satisfaction metrics. Currently, these are not Army metrics in the Logistics Integrated Warehouse (LIW), which only provides these metrics by supply class. However, the purpose of ASLs is to stock readiness drivers as well as other small parts that are very fast moving in order to reduce receipt workload. Thus, the Army's metrics should be aligned to focus on readiness drivers in order to measure whether or not ASL policies are having the intended effect. For example, the overall repair parts fill rate in Iraq has only increased to 40 percent because non-readiness drivers are in the low 30-percent range. In this light, the G–4 staff is pursuing the implementation of ASL metrics in LIW that are limited to readiness drivers in order to align the metrics and the ASL review process.

This successful experience in Southwest Asia provides impetus for changing the ASL requirements determination process across the Army. Accordingly, the G–4 policy for

Southwest Asia will potentially be expanded to all ASL reviews as the Army continues to build on the central-expert ASL review team concept implemented by the Army Materiel Command. All this effort should result in significantly better performing ASLs across the Army, which will, in turn, result in improved Army readiness rates and help get repair parts into the hands of maintenance personnel more quickly.
ALOG

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